COVINGTON & BURLING LLP

1201 PENNSYLVANIA AVENUE NW
WASHINGTON, DC 20004-2401
TEL 202.662.6000
FAX 202.662.6291
WWW.COV.COM

WASHINGTON
NEW YORK
SAN FRANCISCO
LONDON
BRUSSELS

May 17, 2007

VIA FEDERAL EXPRESS

Ms. Mary Fulghum
Associate Regional Counsel
U.S. EPA - Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

Re: Management of TENORM Residuals from Streeterville Area Rights-of-Way

Dear Ms. Fulghum:

This letter is in reply to your April 18, 2007, response to my letter of February 7, 2007, the subject of which was limited to the management of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) residuals from rights-of-way in the Streeterville area.[1] Tronox LLC hopes that, by sharing information and analysis with U.S. EPA, we can establish context and lay the foundation for constructive dialogue in discussions of future remediation within those rights-of-way. As discussed below, it is not apparent from your letter that U.S. EPA disagrees with any of the technical points that my letter on behalf of Tronox LLC raised.

At the outset, however, I wish to address your comments about what you refer to as the "historical and economic backdrop of Tronox LLC's current position." (Attachment 2 at 1.)

First, I want to correct the apparent misapprehension reflected by your statement that "Kerr-McGee LLC 'spun-off' its environmental liabilities." (Id.) Because there has been no entity named "Kerr-McGee LLC," you presumably intended to refer to Kerr-McGee *Chemical* LLC, which in September 2005 merely changed its name to Tronox LLC.[2] That corporate name change had no effect on the entity's rights and responsibilities and Tronox LLC has not spun off anything. Perhaps, instead, you meant to refer to the November 2005 transactions by which Kerr-McGee Corporation spun-off Tronox LLC and other subsidiaries through an initial public

---

[1] My letter of February 7, 2007 and your April 18, 2007 response are included herewith as Attachments 1 and 2, respectively.

[2] Tronox LLC (f/k/a Kerr-McGee Chemical LLC) is the successor to Kerr-McGee Chemical Corporation, which U.S. EPA maintains is the corporate successor to Lindsay Light Company.

offering (IPO) of stock in Tronox Incorporated. That transaction was not a spin-off of "environmental liabilities," but rather the separation of subsidiaries that conduct a variety of ongoing specialty chemicals businesses. The IPO did not affect those subsidiaries' ownership of their own assets nor their responsibility for their own liabilities. Tronox Incorporated and its subsidiaries, including Tronox LLC, constitute the world's third-largest producer and marketer of titanium dioxide pigment. For more information on Tronox Incorporated and its businesses, including Tronox LLC, we invite you to review the 2006 Annual Report, available through the company's website (www.tronox.com).

Second, your reference to a "sum" that you believe was "set aside for the cleanup of radioactive contamination" (id.) seems to reflect a misunderstanding of the nature of an environmental reserve. A reserve is merely an entry on a balance sheet that indicates the currently estimated amount of a future liability or loss contingency. In accord with generally accepted accounting principles (GAAP), a loss reserve is appropriately entered on financial statements when information indicates both (a) that it is probable that a loss will be confirmed by a future event and (b) the amount of the resulting liability can be reasonably estimated.[3] An environmental reserve therefore indicates the current estimate of reasonably certain costs of a remediation effort that is reasonably likely to occur. Tronox LLC is confident that its current environmental reserves comply with GAAP. Insofar as your letter implies, by comparisons to historic remediation spending in West Chicago, that Tronox LLC's environmental reserves for the Streeterville area are inadequate, such implication is wholly unfounded.[4] In any event, the amount of Tronox LLC's environmental reserves should not be taken, as your letter implies, as suggesting any unwillingness by Tronox LLC to satisfy its legal and contractual obligations.

Third, it appears that the reason for your discussion of the "backdrop of Tronox LLC's current position" is to preface the assertion that Tronox LLC has an "incentive to economically 'risk away' the need to protect" workers in the rights-of-way. (Id.) To be clear, Tronox LLC is proposing that U.S. EPA perform a technical assessment of the risk associated with TENORM beneath the rights-of-way and consider how best to manage that risk under typical construction scenarios. Tronox LLC urges U.S. EPA to join in focusing on assessing the risk and determining how to manage it in a reasonable and technically sound manner, rather than on disparaging the company's motives.

---

[3] See FASB, Financial Accounting Standards No. 5 ("Accounting for Contingencies").

[4] I am not aware of what information you are referring to when your letter mentions "[i]nformation provided to U.S. EPA" indicating Tronox LLC's environmental reserves for remediation in the Streeterville area.

During our conversation on April 5, 2007, you said that you were waiting to respond to my letter until after U.S. EPA completed its technical evaluation of Tronox LLC's model risk assessment. That assessment showed that typical construction conditions in the rights-of-way do not present a health risk in excess of 1.0×10^{-6} associated with thorium TENORM residuals. We appreciate the time and effort that U.S. EPA has devoted to reviewing the sample risk assessment and we are pleased to see that the agency has not taken issue with that assessment.

From your letter, however, it appears that the agency believes that the terms of the 1996 Unilateral Administrative Order (hereinafter, the "UAO") and/or the 1999 Right-of-Way Agreement somehow preclude U.S. EPA from applying a risk-based approach to determine appropriate remediation measures for these rights-of-way scenarios. You also appear to suggest that U.S. EPA is compelled to manage any TENORM residuals encountered in short-term, construction-type activities beneath the rights-of-way as though these unique scenarios were identical to remediation at the West Chicago NPL sites. Tronox LLC urges U.S. EPA to reconsider these views.

As I explained in my February 7 letter and reiterate below, the UAO and the 1999 Right-of-Way Agreement do not impose a cleanup level of 7.1 picoCuries/gram for these rights-of-way scenarios. Moreover, as the model risk assessment makes clear, site-specific risk assessments typically would show that it is imprudent to apply a 7.1 picoCuries/gram cleanup standard to these rights-of-way scenarios. For these reasons, Tronox LLC has proposed that U.S. EPA should apply a risk-based approach to the management of any TENORM residuals beneath rights-of-way.

Because your letter seems to address a broader slate of issues, let me reiterate for the sake of clarity that Tronox LLC's proposal is limited to the management of TENORM residuals in connection with short-term construction-type activities in the rights-of-way.

As I also indicated in my February 7 letter, the UAO treats on-site and off-site TENORM residuals differently. Although Section V.3.d of the UAO imposes a cleanup level of 7.1 picoCuries/gram averaged over 100 square meters for TENORM residuals at "the Site" – i.e., the property located at 316 East Illinois Street and (following the 2000 amendment to the UAO) the property known as RV3 North Columbus Drive – the UAO addresses "off-site" areas in a separate provision. The "off-site" provision of the UAO – Section V.3.g – refers generally to implementing "the standards" of 40 C.F.R. 192, which, as I explained, are consistent with a site-specific, risk-based approach to the management of TENORM residuals. (See Attachment 1 at 2.) Your response that a risk-based approach is not required if the material at issue is comparable to tailings found at an UMTRCA site misses the point. (See Attachment 2 at 3.) The issue is not that a risk-based approach is always required, but that a risk-based approach is consistent with 40 C.F.R. 192 and, most importantly, the more prudent approach in these rights-of-way scenarios. We should be able to agree upon the essential point that there is no

compelling reason to apply a cleanup level of 7.1 picoCuries/gram to off-site, short-term, construction-type activities in the rights-of-way when the application of that point-of-reference is unsupported by a site-specific risk assessment and could even lead to higher collective doses and more dangerous construction conditions than a risk-based approach.

Your letter also appears to suggest that the 1999 Right-of-Way Agreement settles the question of how to manage TENORM residuals in the rights-of-way. (Attachment 2 at 3.) That assertion has no basis in the Right-of-Way Agreement. In fact, that Agreement does not mandate that any party must perform a cleanup of TENORM residuals, let alone that all such material in excess of 7.1 picoCuries/gram must be removed for disposal at a facility licensed to accept pre-1978 byproduct material. Rather, the 1999 Right-of-Way Agreement simply sets forth the respective rights and responsibilities of Tronox LLC, River East LLC, and the City of Chicago with respect to designated portions of Grand Avenue, Illinois Street, McClurg Court and Columbus Drive. Tronox LLC's obligation under the Agreement is to indemnify and hold harmless the City in the event that obligations are asserted against City or the City incurs costs with respect to TENORM residuals beneath the designated rights-of-way. 1999 Right-of-Way Agreement at 4 ¶ 6. Tronox LLC has never disavowed the terms of the Agreement.[5] Nor does Tronox LLC's recommendation that U.S. EPA should apply a risk-based approach to the management of TENORM residuals in the rights-of-way constitute a disavowal of its obligations under the Agreement.

In sum, Tronox LLC proposes that U.S. EPA should adopt a reasonable, risk-based approach to the management of any TENORM residuals beneath the rights-of-way. Tronox LLC urges the agency to consider the soundness of our technical and policy position as future decisions concerning the rights-of-way are presented.

Sincerely yours,

Thomas L. Cubbage III
counsel for Tronox LLC

Enclosures

---

[5] As you know, only very minimal TENORM material has been discovered in the more than seven years that U.S. EPA has required gamma surveys to be performed in the rights-of-way.

cc: Mark Krippel (Tronox LLC)
Mort Ames (City of Chicago Corporation Counsel)
Vincent S. Oleszkiewicz (Duane Morris)

ATTACHMENT 1

COVINGTON & BURLING LLP

1201 PENNSYLVANIA AVENUE NW
WASHINGTON, DC 20004-2401
TEL 202.662.6000
FAX 202.662.6291
WWW.COV.COM

WASHINGTON
NEW YORK
SAN FRANCISCO
LONDON
BRUSSELS

February 7, 2007

VIA FEDERAL EXPRESS

Ms. Mary Fulghum
Associate Regional Counsel
U.S. EPA - Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

Re: Management of TENORM Residuals from Streeterville Area Rights-of-Way

Dear Ms. Fulghum:

This letter addresses Tronox LLC's position concerning the management of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) residuals in the area covered by Tronox's September 1999 Right-Of-Way Agreement with the City of Chicago. We propose that cleanup levels for subsurface TENORM residuals within this area should be based on site-specific risk assessments.

Background. The Streeterville area historically was used as a landfill for debris from the Great Chicago Fire and to raise the elevation of the area above Lake Michigan water levels to increase usable land space. Contaminants of concern in this urban landfill environment include PAHs, metals, and TENORM. Potential sources of TENORM might include a former thorium processing plant, secondary uses of thorium materials from the plant and other operations, TENORM contained in materials such as brick and coal ash, and other uncertain or unknown sources.

EPA and the City of Chicago have established a permitting process for construction activities in the area that requires contractors to perform radiation monitoring during any subsurface work in the rights-of-way and report concentrations above 7.1 pCi/g total radium. The recent experiences with the excavation of TENORM residuals in the rights-of-way in the vicinities of 316 East Illinois St. and 355 East Ohio St. suggest that EPA is requiring workers to surgically remove and isolate all material above 7.1 pCi/g total radium for subsequent disposal at a

radioactive waste disposal facility.[1] As discussed below, this approach is unwarranted in light of the exceedingly low level of risk for nearly all construction work in the rights-of-way.

The UAO. At present, there is no agreed upon standard to govern TENORM residuals in the rights-of-way. Section V.3.d of the 1996 Unilateral Administrative Order (UAO) pertaining to "property located at 316 East Illinois Street" (§ I) does not establish a standard that governs the rights-of-way situation. Rather, "off-site" areas are addressed in a separate provision of the UAO, Section V.3.g, which refers generally to implementing "the standards" of 40 C.F.R. 192. See UAO § V.3.g.

If EPA intends to use UAO Section V.3.d to govern its approach to the rights-of-way situation, then it should, at a minimum, give effect to the entirety of Section V.3.d by allowing the averaging of soil concentrations within an excavation on the basis of worker health risk and ALARA, as provided in that provision. See UAO § V.3.d (stating that that the cleanup criterion of 5 pCi/g total radium over background "will be met in each 15 centimeter layer below the surface" and that "[a]veraging over areas up to 100 square meters will be allowed, but only after reasonable efforts have been made to achieve levels As Low As Reasonably Achievable . . . .").

In any event, we are convinced that a risk-based approach is the only proper way to manage these materials. A site-specific risk assessment is consistent with 40 C.F.R. 192. See EPA Memorandum, "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites" (Feb. 12, 1998) (Directive No. 9200.4-25) ("If it is determined . . . that subsurface contamination exists at a level between 5 pCi/g to 15 pCi/g averaged over areas of 100 square meters . . . a cleanup level for the subsurface contamination may have to be established based on a site-specific risk assessment.").

Thus, a risk-based approach is proper under UAO Section V.3.g to address "off-site" areas such as the rights-of-way. It also is, we believe, the approach that leads to the most reasonable outcomes in the field, while adequately protecting public health and the environment.

A Risk-Based Approach. Tronox has prepared an illustrative risk assessment for a generic excavation in the rights-of-way area (enclosed).[2] In brief, this assessment shows that under all

---

[1] Residual soils potentially containing low concentrations of chemical constituents can be disposed of in commercial industrial landfills as special waste without any monitoring or additional requirements.

[2] This illustrative risk assessment was prepared by Mark Krippel of Tronox using EPA's web-based Preliminary Remediation Goals (PRG) for Radionuclides, in an outdoor worker soil (continued...)

but the most extreme circumstances, TENORM materials encountered during brief construction projects of the kind expected to occur in a right-of-way do not present worker health and safety risks above CERCLA guidelines. This information presents an opportunity for EPA to more effectively monitor and control exposure to thorium residuals without negatively impacting the health and safety of workers or the general public.

The risk assessment demonstrates that, under typical construction conditions, the health risks from thorium TENORM residuals that may be encountered within the rights-of-way are well below the 1.0×10^{-6} point of departure and therefore remedial activity would not be required under CERCLA. The results show a total risk of 2.27×10^{-8}, with 98% of the risk from external gamma radiation exposures.[3] With all factors remaining reasonably constant, a construction worker working as many as 44 eight-hour days still would not exceed the target default risk limit of 1.0×10^{-6}.

To screen, remediate and isolate, package, and transport soils at these concentration levels, on the other hand, likely results in higher collective doses. From a construction safety perspective, requirements to monitor and surgically excavate TENORM residuals above 7.1 pCi/g significantly increase the time it takes to complete a right-of-way construction activity. Increasing the time exposed increases the risk from the external exposure pathway, which is by far the primary risk pathway, accounting for more than 98% of the total radiation-associated risk. Moreover, the risk of accidental physical injury to a construction worker in the right-of-way also increases with the time spent working adjacent to traffic and/or within an excavated hole or trench. Consequently, the added monitoring and surgical excavation measures actually increase the overall risk to workers. Furthermore, shipping these materials off-site will result in doses to technicians screening soils, laboratory personnel, shippers, and disposal site personnel. ALARA principles indicate that at a daily risk of 2.27×10^{-8}, the most health-protective solution is to leave the soils in place.

At a minimum, EPA should not require workers to surgically segregate material in excess of 7.1 pCi/g total radium from other excavated soil, but should favor the disposal of such material at an industrial landfill along with the other urban fill soils. The disposal of considerably "hotter" material in industrial landfills is the longstanding, common practice in Illinois. For example, as EPA is undoubtedly aware, sludge from waste treatment plants with TENORM residual concentrations of up to 50 pCi/g has been disposed of in industrial landfills for more than twenty

---

scenario (http://epa-prgs.ornl.gov/radionuclides/), and reviewed with slight modification by Tronox's consultant, SENES Consultants. Both of their papers are enclosed.

[3] This is based on conservative model parameter values and on the assumption that the thorium-232 and its decay products are in secular equilibrium.

years. Also in this regard, recent EPA guidance on the subject of radioactive residuals from treatment plants reminds regulators that "source" material "is *exempt* from NRC or Agreement State regulation if the uranium or thorium makes up less than 0.05 percent by weight (or approximately 335 pCi/g for natural uranium) of the material." *See* EPA Guidance, "A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies," EPA 816-R-05-004, July 2005, P. 12 (enclosed). This disposal of such residual materials demonstrates that the disposal of small volumes of considerably less active excavated soil as though it were regulated Section 11e.(2) waste material is unwarranted.

Because exposure via the external pathway is easily measured and contractors already are required to perform radiation monitoring, direct gamma exposure measurements provide an effective means of ensuring that radiation-associated risks do not exceed the acceptable range under CERCLA. Using the EPA risk factor of 8.46×10^{-4} per rad, the upper end of the acceptable risk in terms of a measured dose would be 118 mrem. Real-time monitoring instruments that measure dose rate and dosimeters that measure accumulated dose are readily available and routinely used by the health-physics contractors performing radiation monitoring for rights-of-way activities.

The Way Forward. In summary, we believe that using 7.1 pCi/g as a criterion to govern excavated material in the rights-of-way is neither required nor technically sound. We therefore propose that a risk-based approach is the proper way to manage materials in the rights-of-way areas not directly governed by express provisions of the UAO. In light of the exceedingly low level of risk, this will mean in almost all cases that no remedial activity should be required.

I appreciate your willingness to consider this information as future decisions concerning the rights-of-way are presented. Tronox would welcome the opportunity to discuss these issues further in connection with such situations.

Sincerely yours,

Thomas L. Cubbage III

Enclosures

cc: Mark Krippel

Illustrative Risk Assessment

Right-of-Way Excavation
Outdoor Worker Soil Scenario

EPA PRG Based Risk Assessment for Construction Workers Performing Utility Installation/Repair in Streeterville Rights-of-Way

Scenario Description- A construction crew performs a utility installation/repair in a Streeterville area right-of-way (ROW). For EPA PRG risk assessment purposes, the job entails digging a trench 10 meters long by 1 meter wide. The depth of the trench is assumed to be greater than 15 cm. The trench is assumed to contain 10 m^2 of soil impacted by thorium decay chain radionuclides in secular equilibrium. The radionuclides selected are Th-232, Ra-228+D, and Th-228+D. The target risk used is the default value of 1.0E-6. An area correction factor (ACF) of 0.4 is applied consistent with EPA guidance for a 10 m^2 area. The fraction of vegetative cover is set to 0.01 to maximize particulate emissions predicted by the model. The duration of exposure is set to one 8-hour work day by setting EF to 1 day per year, ED to 1 year and ET to 0.33 (8 hours/24 hour day). A single work day of exposure was chosen so that the risk per day of exposure can be scaled for longer duration projects. Historically, the duration of these projects is a few days at most. Further, based on the number of City permits issued for the Streeterville area versus the number of thorium related removals conducted, the probability of encountering thorium materials in the area is low.

EPA PRG Web Based Tool Results- A site-specific PRG calculation was run using the parameters for the utility installation scenario. The model output provides PRG radionuclide concentrations at which the target risk of 1.0E-6 would not be exceeded. Slope factors per radionuclide for the 3 exposure pathways (inhalation, ingestion & direct gamma) are also provided in the model output. A printout of the PRG run is attached.

Additionally, the underlying calculations in the model were used to calculate the risk associated with a one work day exposure to thorium chain soils at a concentration of 5 pCi/g above background (7.1 pCi/g). The risk for each pathway was calculated and then summed to provide the total risk per day of work at the EPA action level of 7.1 pCi/g. The total risk per work day of exposure to 7.1 pCi/g thorium soils is 2.27E-8.

Recent Electrical Conduit Installation Case Study- In November 2006, a contractor installed an electrical conduit at 505 N. McClurg over the course of 2 days. The excavation trench produced 4 roll-off boxes (~48 cubic yards) of soil with background soil concentrations. On the 2nd day, approximately 2 cubic yards of thorium soils with a concentration of 7.6 pCi/g were encountered and segregated from the other excavated soils. Using the EPA PRG calculations under the scenario modeled above, the risk associated with working with the 7.6 pCi/g thorium materials for the one day was 2.5E-8. EPA, citing worker health risk and ALARA, required the 2 cubic yards of soils be treated as radioactive material under the Lindsay Light UAO and be disposed of at a licensed radioactive waste disposal site.

Preliminary Remediation Goals for Radionuclides

Topic for Key OSWER Radiation Guidances and Reports

Equation Values for Outdoor Worker Soil

Parameter	Value	Parameter	Value
Target Risk (unitless)	1.0E-6	Exposure Duration (yr)	1
Exposure Frequency (day/yr)	1	Soil Intake Rate (mg/day)	100
Inhalation Rate (m^3/day)	60	Time of Exposure (yr)	1
Outdoor Exposure Time Fraction (unitless)	0.33	Indoor Exposure Time Fraction (unitless)	0.0
Indoor Dilution Factor (unitless)	0.4	Area Correction Factor (unitless)	0.4
Gamma Shielding Factor (m^3/kg)	0.4	City (Climatic Zone)	Chicago (VII)
Surface Area (acres)	0.5	Q/C (g/m^2-s per kg/m^3)	97.78
Fraction of Vegetative Cover	0.01	Mean Annual Windspeed (m/s)	4.65
Equivalent Threshold Value of Windspeed at 7m (m/s)	11.32	F(x) (unitless)	0.182
Particulate Emission Factor (m^3/kg)	7.83E+08		

Radionuclide Preliminary Remediation Goals for Outdoor Worker Soil

Chemical	Industrial Exposure Soil Ingestion Slope Factor (Risk/pCi)*	Inhalation Slope Factor (Risk/pCi)	External Exposure Slope Factor (Risk/yr per pCi/g)	PRG (pCi/g)	PRG (mg/kg)
Ra-228+D decaychain	6.70E-10	5.23E-09	4.53E-06	6.22E+02	2.28E-06
Th-228+D decaychain	1.62E-10	1.43E-07	7.76E-06	4.22E+02	5.14E-07
Th-232 decaychain	8.47E-11	4.33E-08	3.42E-10	1.03E+05	9.45E+05
	9.167E-10	1.915E-7	1.229E-5	5.22E+2	

* Soil Ingestion Slope Factor is calculated for ages 18thru 65 and is only available for certain radionuclides.

So.1 Ingestion Risk per day for 7.1 pCi/g (5 above bkgd)

0.19 g/day × 9.167 E-10 $\frac{\text{risk}}{\text{pCi}}$ × $\frac{5\text{ pCi}}{\text{g}}$ =

= 4.58 E-10 risk per day

Inhalation Risk per day for 7.1 pCi/g (5 above bkgd)

$\frac{1000\text{ g/kg}}{7.83\text{ E+8 m}^3\text{/kg}}$ × 60 m³/day × .33 days (8 hours) =

2.53 E-5 pCi-g/day × 1.915 E-7 $\frac{\text{risk}}{\text{pCi}}$ × $\frac{5\text{ pCi}}{\text{g}}$

= 2.42 E-11 risk per day

External Gamma Risk per day for 7.1 pCi/g (5 above bkg)

1.229 E-5 $\frac{\text{risk/yr}}{\text{pCi/g}}$ × $\frac{5\text{ pCi}}{\text{g}}$ × $\frac{1}{365\text{ day/yr}}$ × 0.64 ACF × 0.33 day (8 hours) =

= 2.22 E-8 risk per day

Total = 2.27 E-8 risk per day

EPA Risk 8.46 E-4/rad

Preliminary Remediation Goals for Radionuclides

Topic for Key OSWER Radiation Guidances and Reports

Outdoor Worker Soil

The outdoor worker soil landuse equation, presented here, contains the following exposure routes:

- incidental ingestion of soil,
- inhalation of particulates emitted from soil, and
- external exposure to ionizing radiation.

$$C_{(pCi/g)} = \frac{TR \times t_w \times \lambda}{EF_{ow} \times ED_{ow} \times \left(1 - e^{-\lambda t_w}\right) \times \left[\begin{array}{l} \left(SF_s \times IR_{sow} \times 10^{-3}\,(g/mg)\right) + \left(SF_i \times IR_{ow} \times \frac{10^3\,(g/kg)}{PEF} \times \left[ET_{owo} + (ET_{owi} \times DF_i)\right]\right) + \\ \left(SF_e \times \frac{1}{365\,(d/yr)} \times ACF \times \left[ET_{owo} + (ET_{owi} \times GSF)\right]\right) \end{array}\right]}$$

Table 1. Standard Default Factors

Symbol	Definition (units)	Default	Reference
Slope Factors			
SF_s	Ingestion Slope Factor - soil (risk/pCi)	–	HEAST
SF_i	Slope Factor - inhalation (risk/pCi)	–	HEAST
SF_e	Slope Factor - external exposure (risk/yr per pCi/g)	–	HEAST
Dose and Decay Constant Variables			
TR	Target Risk	1×10^{-06}	

t_w	Time - worker (years)	25	U.S. EPA 1991a (pg. 15)
λ	Decay Constant = 0.693/halflife	--	Developed for Radionuclide Soil Screening calculator
Miscellaneous Variables			
DF_i	Dilution Factor - indoor (unitless)	0.4	U.S. EPA 2000a. (pg. 2-20). U.S. EPA 2000b. (pg. 2-13)
ACF	Area Correction Factor (unitless)	0.9	U.S. EPA 2000a. (pg. 2-22). U.S. EPA 2000b. (pg. 5-1)
GSF	Gamma Shielding Factor (unitless)	0.4	U.S. EPA 2000a. (pg. 2-22). U.S. EPA 2000b. (pg. 2-18)
Inhalation, Ingestion, and Consumption Rates			
IR_{ow}	Inhalation Rate - outdoor worker (m^3/day; based on a rate of 2.5m^3/hr for 24hr)	60	U.S. EPA 1997a (pg. 5-11)
IR_{sow}	Soil Ingestion Rate - outdoor worker (mg/day)	100	U.S. EPA 2001 (pg. 4-3)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{ow}	Exposure Frequency - outdoor worker (days/yr)	225	U.S. EPA 1991a (pg. 15)
ED_{ow}	Exposure Duration - outdoor worker (yr)	25	U.S. EPA 1991a (pg. 15)
ET_{owi}	Outdoor Worker Exposure Time - indoor (hr/hr)	0	
ET_{owo}	Outdoor Worker Exposure Time - outdoor (hr/hr)	0.33	Eight Hours per Day
Particulate Emission Factor Variables			
PEF	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36×10^9	U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
Q/C	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source (g/m^2-s per kg/m^3)	93.77	U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
V	(fraction of vegetative cover) unitless	0.5	U.S. EPA 1999b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
U_m	mean annual wind speed) m/s	4.69	U.S. EPA 1999b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
U_t	equivalent threshold value of wind speed at 7m) m/s	11.32	U.S. EPA 1991b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 32)
F(x)	function dependent on U_m/U_t) unitless	0.194	U.S. EPA 1991b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)

ANL. 1993. Manual for Implementing Residual Radioactive Materials Guidelines Using RESRAD, Version 5.0. Argonne National Laboratory, Argonne, IL. ANL/EAD/LD-2

IAEA. 1994 Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. International Atomic Energy Agency

NEC. Swine Nutrition Guide. Cooperative Extension Service / South Dakota State University and University of Nebraska / U.S. Department of Agriculture. Nebraska Cooperative Extension EC 95-273-C. http://www.ianr.unl.edu/pubs/swine/ec273.pdf The pig water ingestion numbers are derived from the USDA "Swine Nutrition Guide. " USDA assumes a pig consumes 1/4 to 1/3 gallon of water for every pound of dry feed. The midpoint of this range (7/24 gallons of water) was used with the default dry feed (4.7 kg) to come up with 11.4 gallons per day default water intake.

NCRP. 1996 Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground, Vols. 1 and 2, NCRP Report No. 123. National Council on Radiation Protection and Measurements. http://www.ncrp.com/rpt123.html

U.S. EPA. 1988. Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion. Federal Guidance Report No. 11. Office of Radiation Programs, Washington, DC. EPA-520/1-88-020. http://www.epa.gov/radiation/federal/techdocs.htm#report11

U.S. EPA 1989. U.S. Environmental Protection Agency (U.S. EPA). Risk assessment guidance for Superfund. Volume I: Human health evaluation manual (Part A). Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002. http://www.epa.gov/superfund/programs/risk/ragsa/

U.S. EPA 1990. Interim Final Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions. Environmental Criteria and Assessment Office. ORD. EPA-600-90-003. January.

U.S. EPA 1991a. U.S. Environmental Protection Agency (U.S. EPA). Human health evaluation manual, supplemental guidance: "Standard default exposure factors". OSWER Directive 9285.6-03.

U.S. EPA 1991b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals). Office of Emergency and Remedial Response. EPA/540/R-92/003. December 1991 http://www.epa.gov/superfund/programs/risk/ragsb/index.htm

U.S. EPA. 1993. External Exposure to Radionuclides in Air, Water, and Soil. Federal Guidance Report No. 12. Office of Radiation and Indoor Air, Washington, DC. EPA 402-R-93-081. http://www.epa.gov/radiation/federal/docs/fgr12.pdf

U.S. EPA. 1994a. Estimating Exposure to Dioxin-like Components - Volume III: Site-Specific Assessment Procedure. Review Draft. Office of Research and Development. Washington D.C. EPA/600/6-88/005Cc. June. (Also see U.S. EPA. 1994c for direct link to Table) http://www.epa.gov/ORD/exposure/exposure.pdf

U.S. EPA 1994b. Radiation Site Cleanup Regulations: Technical Support Documents for the Development of Radiation Cleanup Levels for Soil – Review Draft. Office of Radiation and Indoor Air, Washington, DC. EPA 402-R-96-011A. http://www.epa.gov/radiation/cleanup/tsd/intro.pdf View Appendix C here

U.S. EPA. 1994c. Revised Draft Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Wastes. Attachment C, Draft Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities. Office of Emergency and Remedial Response. Office of Solid Waste. December 14. http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/volume_3/appc1-8.pdf

U.S. EPA. 1996a. Soil Screening Guidance: User's Guide. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-23 http://www.epa.gov/superfund/resources/soil/index.htm#user

U.S. EPA. 1996b. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response.

Washington, DC. OSWER No. 9355.4-17A http://www.epa.gov/superfund/resources/soil/introtbd.htm

U.S. EPA. 1997a. Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa. http://www.epa.gov/ncea/pdfs/efh/

U.S. EPA. 1997b. Parameter Guidance Document. National Center for Environmental Assessment, NCEA-0238.

U.S. EPA. 1998. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Office of Solid Waste, Washington, DC. EPA530-D-98-001A http://www.epa.gov/epaoswer/hazwaste/combust/risk.htm

U.S. EPA. 1999a. Data Collection for the Hazardous Waste Identification Rule. Office of Solid Waste, Washington, DC. http://www.epa.gov/epaoswer/hazwaste/id/hwirwste/risk.htm

U.S. EPA 1999b. Volume II, "Review of Geochemistry and Available Kd Values for Cadmium, Cesium, Chromium, Lead, Plutonium, Radon, Strontium, Thorium, Tritium (3H), and Uranium. Office of Radiation and Indoor Air. Washington, DC. EPA 402-R-99-004B, August 1999. http://www.epa.gov/cgi-bin/claritgw?op-Display&document=clserv:OAR:0232;&rank=4&template=epa

U.S. EPA 1999c. Cancer Risk Coefficients for Environmental Exposure to Radionuclides. Office of Radiation and Indoor Air. EPA 402-R-99-001. September 1999. http://www.epa.gov/radiation/federal/docs/fgr13.pdf

U.S. EPA. 2000a. Soil Screening Guidance for Radionuclides: User's Guide. Office of Emergency and Remedial Response and Office of Radiation and Indoor Air. Washington, DC. OSWER No. 9355.4-16A http://www.epa.gov/superfund/resources/radiation/radssg.htm#user

U.S. EPA. 2000b. Soil Screening Guidance for Radionuclides: Technical Background Document. Office of Emergency and Remedial Response and Office of Radiation and Indoor Air. Washington, DC. OSWER No. 9355.4-16 http://www.epa.gov/superfund/resources/radiation/radssg.htm#guide

U.S. EPA 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. March 2001. http://www.epa.gov/superfund/resources/soil/index.htm

---

Waste and Cleanup Risk Assessment Home
Basic Information
Where You Live
Waste and Cleanup Programs' Risk Assessment
Risk Assessment Topics
Policy Guidance
Databases and Tools
Alphabetical List of Documents
Frequent Questions
Related Links
Glossary
Site Map

PRG Home | PRG Search | What's New | Frequently Asked Questions | User's Guide | Equations | Download Area

Preliminary Remediation Goals for Radionuclides

Topic for Key OSWER Radiation Guidances and Reports

Area Correction Factor

The risk model used for the external radiation exposure pathway in this guidance effectively assumes that an individual is exposed to a source geometry that is effectively an infinite slab. The concept of an "infinite slab" means that the thickness of the contaminated zone and its aerial extent are so large that it behaves as if it were infinite in its physical dimensions. In practice, soil contaminated to a depth greater than about 15 cm and with an aerial extent greater than about 1,000 m^2 (i.e., one-quarter acre) will create a radiation field approaching that of an infinite slab.

This infinite slab assumption has been used in the calculation of radionuclide slope factors presented in Section 2.1. For very small areas of contamination, this will result in overly conservative estimates of risk. For calculation of SSLs for a residential setting, an adjustment for source area is considered to be an important modification for Superfund sites. Thus, an area correction factor, ACF, has been added to the SSL calculation.

Table 5.1 provides recommended ACFs for radionuclides as a function of source area calculated using MicroShield V5.01.1 Since the default source size is 0.5-acre (i.e., 2,000 m^2), the default ACF for SSL equations is set at 0.9. The calculations assume for a uniform layer of contamination 15 cm deep with a soil density of 1.6 g/cm^3. A single recommended value is considered suitable for all radionuclides over the range of source areas since EPA's analysis shows that ACFs vary little from one radionuclide to another. For other source areas, recommended ACFs are presented in Table 5.1.

Table 5.1 Recommended Area Correction Factors as Function of Source Area Source Area

Source Area (m^2)	ACF
10,000	1.00
5,000	0.94
2,000	0.90
1,000	0.88
500	0.86
100	0.75
50	0.66
10	0.4

EPA's analysis of ACFs is found in Table 5.2, which provides examples of ACFs for several radionuclides as a function of source area calculated using MicroShield V5.01. The calculations assume for a uniform layer of contamination 15 cm deep with a soil density of 1.6 g/cm^3. Strong gamma-ray emitters like ^{60}Co have relatively large slope factors for this pathway relative to the

SENES Consultants Limited

121 Granton Drive
Unit 12
Richmond Hill, Ontario
Canada L4B3N4

Tel: (905) 764-9380
Fax: (905) 764-9386
E-mail: senes@senes.ca
Web Site: http://www.senes.ca

34462

4 December 2006

Mr. Mark Krippel
Tronox, LLC
800 Weyrauch St.
West Chicago, IL 60185

Re: EPA PRG Risk-Based Assessment of Construction Workers Performing Utility Installation/Repair in Streeterville Rights-of-Way: Review of Calculations

Dear Mr. Krippel:

As described in your e-mail last week, you performed a preliminary risk assessment of utility installation work in Streeterville rights-of-way resulting from the presence of above-background concentrations of natural thorium (Th-232) contamination in the soil. You used EPA's web-based calculator for Preliminary Remediation Goals (ORG) available at http://epa-prgs.ornl.gov/radionuclides/prg_search.shtml to estimate the risk to workers digging a trench 10 m long by 1 m wide. Further to your request, we undertook a review of your use of the PRG calculator. The result of our review is the subject of this letter.

Your e-mail included the values of the input parameters and the resultant output from the EPA PRG calculator for the Outdoor Worker Soil scenario. You also forwarded your associated hand-calculations for an above-background concentration of Th-232 (plus decay products in equilibrium) of 5 pCi/g. You estimated a risk to workers of 2.27×10^{-8} per day of work, with essentially all the risk (98%) being due to external gamma radiation. In brief, with one minor change as explained below, we agree with the results of your calculations.

The PRG calculator enables the calculation of risk for exposure to individual radionuclides or for a series of radionuclides in equilibrium (denoted as "+D"). However, the calculator does not allow the calculation for the entire Th-232 decay series at once. As you did in your assessment, the calculations must be performed for each of Th-232, Ra-228+D (to Ac-228) and Th-228+D (to Pb-208). The PRG calculator for the Outdoor Worker Soil scenario calculates exposures and risks for the ingestion, inhalation and external gamma radiation exposure pathways. The PRG equation values for this scenario and the resultant PRGs are shown in Tables 1 and 2.

Table 1: PRG Calculator – Input Values for Outdoor Worker Soil Scenario

Parameter	Value	Parameter	Value
Target Risk (unitless)	1.00E-06	Exposure Duration (y)	**1**
Exposure Frequency (day/y)	**1**	Soil Intake Rate (mg/day)	100
Inhalation Rate (m^3/day)	60	Time of Exposure (yr)	**0.001**
Outdoor Exposure Time Fraction (unitless)	0.33	Indoor Exposure Time Fraction (unitless)	0
Indoor Dilution Factor (unitless)	0.4	Area Correction Factor (unitless)	**0.4**
Gamma Shielding Factor (m^3/kg)	0.4	City (Climatic Zone)	**Chicago (VII)**
Surface Area (acres)	0.5	Q/C (g/m^2-s per kg/m^3)	*97.78*
Fraction of Vegetative Cover	**0.01**	Mean Annual Windspeed (m/s)	*4.65*
Equivalent Threshold Value of Windspeed at 7m (m/s)	11.32	F(x) (unitless)	*0.182*
Particulate Emission Factor (m^3/kg)	*7.83E+08*		

a. Parameter values shown in **bold** changed from EPA default values. All values same as your calculations except for time of exposure (see text).
b. Parameter values shown in *italics* automatically changed by PRG model because of changed input parameters.

Table 2: Radionuclide Preliminary Remediation Goals (PRGs) for Outdoor Worker Soil

Chemical	Soil Ingestion Slope Factor (risk/pCi)	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/y per pCi/g)	PRG (pCi/g)
Th-232	8.47E-11	4.33E-08	3.42E-10	1.03E+05
Ra-228+D	6.70E-10	5.23E-09	4.53E-06	5.86E+02
Th-228+D	1.62E-10	1.43E-07	7.76E-06	3.54E+02
Totals =	9.17E-10	1.92E-07	1.23E-05	2.20E+02

a. The PRG total is an inverse-weighted total (see text).

The values shown in bold in Table 1 indicate those parameters that were changed from the EPA default values by us. Identical to your inputs, an exposure duration of 1 y and an exposure frequency of 1 d/y were chosen so that the risk per day of exposure could be scaled for longer duration projects as necessary. Also, the fraction of vegetative cover was set to 0.01 to maximize particulate emissions predicted by the model. (Note: using a smaller value of 0.001 gave the same PRG results.) The area correction factor (ACF) was set to the value of 0.4 to be consistent with the ACF for the minimum area 10 m^2 used in the EPA model. (The ACF corrects for areas of less than semi-infinite extent on which the external exposure slope factors are based.) The climatic zone was chosen for the City of Chicago (EPA Region VII), which affects air dispersion and particulate emission factors calculated by the model, shown in italics in Table 1.

The only input value changed from your calculations was the time of exposure which was set to the vanishingly small 0.001 y (the model does not run for 0 y) rather than the 1 y value used in your calculations. The reason for this is as follows.

The EPA calculator uses the time of exposure parameter (t_w in the model) to model the decay of radionuclides (or radionuclide series) over the time of exposure. (The outdoor worker equation in the PRG calculator uses the multiplier $t_w\lambda/(1-\exp(-t_w\lambda)$ for this purpose. This multiplier approaches 1 as t_w approaches 0.) However, the calculation is done independently for each series. Fore example, while the Th-232 is decayed with its half-life (= $\ln(2)/\lambda$) of 1.4×10^{10} y (i.e. essentially no decay), the Ra-228+D and Th-228+D sub-series are decayed with their much smaller half-lives of approximately 6 y and 2 y, respectively. This results in a loss in radioactive equilibrium for the Th-232 series. This can be seen by changing the "time of exposure" parameter to various values. Only the PRG values for the Ra-228+D and Th-228+D series are affected. To prevent this, this parameter should be set to a small level (0 does not work), as shown in Table 1. (Note: I have communicated via e-mail with the EPA contact for the PRG calculator, but they have not yet responded to confirm this approach.)

The resulting PRGs based on our calculations are shown in Table 2. The PRGs (pCi/g) for the Ra-228+D (586 pCi/g) and Th-228+D series (354 pCi/g) differ from your calculated values of 622 pCi/g and 422 pCi/g, respectively, because your exposure duration was set to 1 y. This artificially decayed these sub-series, and resulted in larger PRGs.

Each PRG represents the target default risk of 1×10^{-6} i.e. concentration/PRG = a risk of 1×10^{-6}. The combined PRG for the Th-232 series for the risk target of 1×10^{-6} is calculated by the inverse of the sum of the inverse PRGs (i.e. $1/PRG_{tot} = 1/PRG_1 + 1/PRG_2 + \ldots$) with the result that the PRG (Th-232 series) = 220 pCi/g as shown in Table 2. The corresponding risk for one day of exposure by the workers to 5 pCi/g of Th-232 (and decay products in equilibrium) would therefore be;

$$\text{risk (5 pCi/g)} = (5/220) \times (1 \times 10^{-6}) = \mathbf{2.27 \times 10^{-8}}$$

This is the same as your hand-written estimate because you used the slope (risk) risk factors, not the PRGs, for your calculations. Using the total ingestion, inhalation and gamma slope (risk) factors shown in Table 2 as you did, the risks per day of exposure for each exposure pathway are:

Ingestion risk = 100 mg/d x 0.001 g/mg x 5 pCi/g x (9.17×10^{-10} risk/pCi)
= $\mathbf{4.59 \times 10^{-10}}$

Inhalation intake = ($1 / 7.83 \times 10^{8}$ m^3/kg) x 10^3 g/kg x 60 m^3/d x 0.33 d (= 8 h)
= 2.55×10^{-5} g/d

Inhalation risk = 2.55×10^{-5} g/d x 5 pCi/g x 1.92×10^{-7} risk/pCi
= $\mathbf{2.45 \times 10^{-11}}$

Ext. gamma risk = 1.23×10^{-5} risk/y per pCi/g x 0.4 ACF x 5 pCi/g x 1/365 d/y x 0.33 d
= **2.22×10^{-8}**

Total risk = **2.27×10^{-8}**

This calculation is consistent with the calculation based on the PRGs. As you concluded, this calculation also shows that the inhalation and ingestion risks are insignificant relative to the gamma radiation risk (which is also insignificant). You should however be aware that as explained in the PRG Users Guide (Section 4.8.1, also available on-line), the inhalation risk from the PRG calculator is based on wind-borne dust emissions. Mechanical disturbance by traffic or the workers could increase dust levels. However, increasing the inhalation risk by as much as x100 would still make the inhalation risk small relative to the gamma radiation risk.

We trust that this review meets with your needs. Please contact either of us if you have any questions or require further information.

Yours very truly,

SENES Consultants Limited

Leo M. Lowe, Ph.D., P.Phys.
Principal, Senior Health and
Environmental Physicist

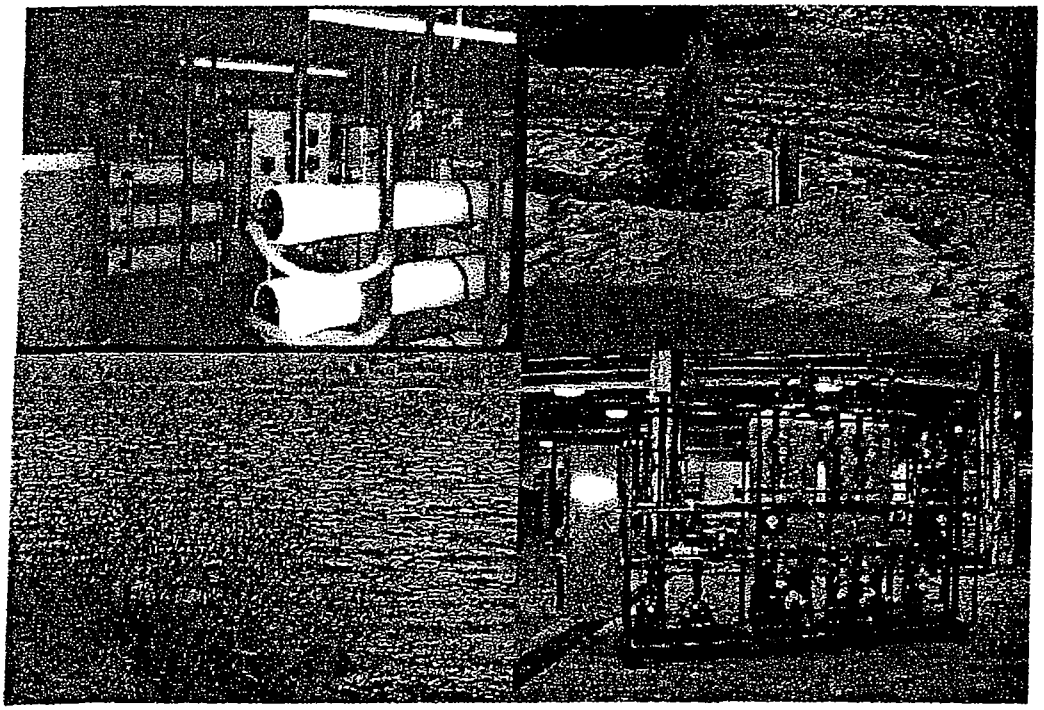
Douglas B. Chambers, Ph.D.
Vice President, Director of
Radioactivity and Risk Studies

EPA Guidance

Management of Radioactive Residuals from Drinking Water Treatment Technologies

EPA
United States
Environmental Protection
Agency

A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies



ATTACHMENT 2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGIONS 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 1 8 2007

REPLY TO THE ATTENTION OF: C-14J

VIA FACSIMILE AND FIRST CLASS MAIL

Thomas L. Cubbage
Covington & Burling
1201 Pennsylvania Av. NW
Washington, D. C

Re: Lindsay Light Radioactive Thorium Contamination in Streeterville Area Rights of Way and Properties

Dear Mr. Cubbage:

This letter responds to your letter dated February 7, 2007 that explains Tronox LLC's (successor corporation to the Lindsay Light Company and Kerr-McGee Chemical LLC) latest position regarding the management of radioactive thorium contaminated soils associated with the Lindsay Light Company in an area of Chicago known as Streeterville. I have not yet had the pleasure meeting you personally but have worked extensively with members of Covington and Burling for more than a decade on issues related to Lindsay Light in the cities of Chicago and West Chicago and I look forward to meeting you. U.S. EPA welcomes a dialogue with respect to the identification, management and removal of thorium tailings and other radioactive contamination associated with Lindsay Light in the Streeterville neighborhood of Chicago.

It is important to recognize the historical and economic backdrop of Tronox LLC's current position. Upon reaching agreement with the United States regarding the settlement of claims and the cleanup of the four Kerr-McGee National Priority List (NPL) sites in DuPage County, Kerr-McGee LLC "spun-off" its environmental liabilities, including its Lindsay Light liabilities, into Tronox LLC. Information provided to U.S. EPA indicates that Kerr-McGee LLC apparently chose to provide Tronox LLC with an environmental reserve of less than $1,000,000 to cover Lindsay Light liability for thorium and associated radioactive contamination in the downtown Chicago Streeterville neighborhood.

When one considers that Lindsay Light operated in downtown Chicago for over 30 years and in West Chicago/DuPage County for nearly 40 years, and that the West Chicago cleanup costs were expected to exceed $700 million, it is surprising that such an insignificant sum was set aside for the cleanup of radioactive contamination in downtown Chicago. Your letter concludes that risks to utility and construction workers increase if the thorium contaminated material is removed due to their extended time in a trafficked area and consequently, "in almost all cases ... no remedial activity should be required." Given the funding level of the Lindsay Light environmental reserve, it is easy to understand Tronox LLC's incentive to economically "risk away" the need to protect utility and construction workers and the people of the City of

Chicago. The radiation emitted from the thorium tailings in Chicago is no different from the radiation emitted from the thorium tailings and associated radioactive materials in West Chicago/Dupage County. The people living and working in the City of Chicago are no less entitled to the same level of protectiveness provided to the people of DuPage County. U.S. EPA remains committed to protecting construction and utility workers and the people of Chicago from uncontrolled exposure to the radioactive wastes generated by Tronox LLC's predecessors. The 7.1 pCi/g based upon 40 CFR Part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, remains relevant and appropriate and protective of human health.

Your letter begins by explaining that it addresses "Tronox LLC's position concerning the management of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) residuals in the area covered by Tronox's September 1999 Right-of-Way Agreement with the City of Chicago." Although your letter does not discuss the Lindsay Light Company, certainly you are aware that Lindsay Light and successor corporations ("Lindsay Light") processed radioactive thorium and manufactured gas mantles at several facilities in downtown Chicago beginning in approximately 1902. Indeed, by 1914 Lindsay Light reportedly was one of the world's largest manufacturers of thorium nitrate. It was not until 1936 that Lindsay Light moved its operations 35 miles west to the city of West Chicago. Lindsay Light's West Chicago thorium processing and manufacturing created enormous quantities of radioactive thorium mill tailings that were windblown, carried by runoff waters and or used as fill material on residential, commercial and municipal properties. By 1992, the U.S. EPA had designated the four Kerr-McGee West Chicago NPL sites. U.S. EPA Region 5 developed "Action Criteria" which were the basis of the cleanup standards for the Kerr-McGee West Chicago sites. U.S. EPA eventually issued two unilateral administrative orders to Kerr-McGee for the West Chicago Residential Areas Sites and Reed-Keppler Park site. Unlike West Chicago, however, the Streeterville neighborhood in downtown Chicago was not nominated to the NPL, in part, because the extent of Chicago's radioactive thorium and associated contamination could not be delineated as readily as the radioactive contamination in West Chicago. After Kerr-McGee declined to enter into any consensual agreement, in 1996 U.S. EPA was forced to issue a unilateral administrative removal order to Kerr-McGee and a developer for the cleanup of thorium at the 316 East Illinois removal site in Streeterville.

The 1999 Right-of-Way Agreement entered into among Kerr-McGee, the City of Chicago and River East LLC addressed what was described as "an ingredient in gas mantel (sic) manufacturing [that] is extracted from sand and formed into a solution... It is believed that Section 11(e)(2) material, 42 U.S.C. 2014(e)(2) from this processing process is found at and around the Site." Note that in a letter dated August 25,1995, Kerr-McGee urged the State of Illinois to reclassify the Streeterville thorium contaminated material as byproduct material from a monazite processing operation. In fact, attachments to Kerr-McGee's reclassification request show that Lindsay Light used the same equipment and processes at Streeterville and West Chicago, and consequently, both monazite processing operations generated thorium mill tailings

and associated radioactive contamination.

U.S. EPA had requested that Kerr-McGee, the City of Chicago and the owner and developer of the former monazite processing property enter into the 1999 Right-of-Way Agreement to ensure that thorium contamination present beyond the 316 E. Illinois property boundaries was properly managed and cleaned up. Your letter disregards Kerr-McGee's stipulation in paragraph 2 g. of 1999 Right-of-Way Agreement that states "[i]f subsequent sampling and analysis indicates the presence of contaminants associated with Thorium Residuals beneath the designated rights-of-way, then those areas shall be subject to and covered by this Agreement." Therefore, it is incorrect to now claim that "at present, there is no agreed upon standard" regarding the cleanup of radioactive thorium contamination in the rights-of-way.

Tronox LLC has previously refuted its1999 Right-of-Way Agreement responsibilities. In October 2006, Tronox LLC suddenly refused to transport and dispose of radioactive thorium contamination in excess of 7.1 pCi/g discovered in a designated right-of-way and caused considerable delay and expense to several affected parties including U.S. EPA. Tronox LLC's decision to disavow the terms of the 1999 Right-of-Way-Agreement is troubling. While such behavior may save Tronox LLC resources in the immediate short term, it is likely, however, that it will soon cause significant and entirely unnecessary additional expenditures.

In the City of West Chicago and DuPage County, Kerr-McGee/Tronox LLC removed radioactive thorium contamination from streets and rights-of-ways to the risk-based cleanup standard of 7.2 pCi/g derived from 40 CFR Part 192. The 40 CFR Part 192 standard of 5 pCi/g over background that was appropriate for neighborhoods (including streets, sidewalks, and utility rights-of-ways), a park, sewage treatment plant and a river in West Chicago and DuPage County is just as appropriate for the Streeterville neighborhood in downtown Chicago. Consistent with 40 CFR Part 192, U.S. EPA has allowed averaging over areas up to100 square meters after efforts were made to achieve levels as low as reasonably achievable in West Chicago/DuPage County and also in the Streeterville neighborhood of downtown Chicago. Tronox LCC does not explain why the West Chicago/DuPage County standard is not appropriate for the workers and people living in Streeterville but simply concludes that "[i]n any event we are convinced that a risk-based approach is the only proper way to manage these materials."

As the EPA guidance you cite explains, "[t]he concentration criterion for surface soil (5 pCi/g of radium-226) is a health-based standard. The relevant source of health risk for surface soil is exposure to gamma radiation, which is the basis for this standard." Your letter then conveniently ignores critical terms to twist the meaning of the guidance. The terms not included were references to the similarity between an Uranium Mill Tailings Radiation Control Act, 42 U.S.C. 2022 et seq. (UMTRCA) site and the site at hand. As discussed earlier, the material at issue here is thorium mill tailings, which are quite comparable to the tailings found at an UMTRCA site. Indeed, Tronox has regularly identified the radioactive waste material shipped from the Lindsay Light II sites to the Utah Department of Environmental Quality as "pre-1978

11e(2) byproduct material." There is no compelling reason to now dispense with the health-based radioactive thorium mill tailings cleanup standard that has been consistently applied in Streeterville and West Chicago for over a decade.

In several instances, your letter complains that the radioactive thorium material must be "surgically" removed from rights-of-ways. It is our understanding that the material is removed with shovels or other excavation equipment. In our experience, these are not instruments typically associated with surgery. Furthermore, it is also our understanding that contractors removing the material are endeavoring, at Tronox LLC's insistence, to only remove soils in excess of 7.1 pCi/g to minimize Tronox LLC's transportation and disposal costs. Tronox LLC's insistence upon minimizing the volume of radiologically impacted materials transfers and significantly increases the burden and cleanup cost to those performing the excavation work. Because there are no Lindsay Light disposal records, and there has been no discernable pattern observed in the radioactive contamination encountered in Streeterville, unless Tronox LLC is willing to conduct a thorough investigation of potentially contaminated off-site areas or is willing to accept more radiologically-impacted material, workers will continue their efforts to minimize the removal of radioactively contaminated materials to control Tronox LLC's costs.

Tronox LLC also requests to dispose of the pre-1978 byproduct material "at an industrial landfill" because certain TENORM materials have been disposed of in such landfills. As you are aware due to the patchwork of agencies, laws, and policies regulating the management of radioactive materials, materials exhibiting similar radioactive characteristics are not always managed consistently but that does not persuade U.S. EPA that the least protective disposal method is acceptable for these radioactive materials. The State of Illinois also has established a comprehensive program for the timely decontamination of properties that are contaminated with thorium mill tailings. As Tronox LLC has acknowledged in West Chicago, the Comprehensive Environmental Response, Compensation and Liability Act 42 U.S.C. 9601 *et seq.* (CERCLA) is the source of U.S. EPA's responsibility to protect human health from actual or threatened releases of thorium. Radioactive thorium tailings in Chicago should continued to be managed and disposed in a manner not inconsistent with the West Chicago radioactive thorium sites including disposal at a facility licensed to accept pre-1978 byproduct material.

Unfortunately, radioactive thorium tailings are odorless, colorless, often mixed with other materials, and can only be detected by trained professionals using calibrated radiation detection equipment. Further complicating the management of this waste is thorium's 14 billion year half-life that demands precautions to prevent its uncontrolled release until it is safely removed and properly disposed of. U.S. EPA urges Tronox LLC to work cooperatively with the City of Chicago, property owners and developers, citizens groups, construction and utility unions, and U.S. EPA to prevent the release of Tronox LLC's radioactive thorium contamination present in the Streeterville neighborhood of Chicago. For Tronox LLC, the least expensive approach to the problem of radioactive thorium contamination in Chicago will require the cooperative

implementation of the 1999 Right-of-Way Agreement and working closely with the Chicago and U.S. EPA to remove radioactive thorium contamination from throughout the Streeterville neighborhood as contemplated by the 1996 Unilateral Administrative Order. U.S. EPA is interested in reopening a dialogue with Tronox LLC with respect to the characterization of the extent of thorium contamination in downtown Chicago to finally achieve the requirements of the 1996 Unilateral Administrative Order which required the investigation and cleanup of "off-site" radioactive thorium contamination.

Again, I look forward to meeting you and working together to cleanup the radioactive thorium contamination in Streeterville. Please contact me at (312) 886-4683 or Cathleen Martwick at (312) 886-7166 if you wish to discuss this further.

Sincerely,

Mary L. Fulghum
Associate Regional Counsel

cc: Mort Ames, City of Chicago Corporation Counsel
Vincent S. Oleszkiewicz, Duane Morris